A THESIS ON

D I A B E T E S M E L L I T U S

Its Treatment by

ABSTINENCE FROM FOOD

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by

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D I A B E T E S M E L L I T U S.

In setting out to treat cases of disease physiology and pathology are the branches of medicine to which the clinician looks for guidance; physiology to throw light on normal function, pathology to provide detail of the manner in which function becomes deranged and of the tissue lesion associated with such derangement.

Diabetes Mellitus, by means of these two sciences, has been within recent years withdrawn to an appreciable extent, from that obscurity in which it previously lay. The brilliant experimental research work carried out by von Mering and Minkowski in the latter two decades of last century in relation to the pancreas and its internal secretion, threw a flood of light on carbohydrate metabolism. It is a notable fact however that these recent findings have, in a small measure only, modified the treatment of this disease.

As far back as 1797, without knowledge either of the Islets of Langerhans or of their function or pathology, Rollo found that cases suffering from diabetes mellitus, when deprived of sugar and mealstuffs, improved in their general condition and that the amount of sugar in the urine decreased or disappeared.

Rollo was the first to discuss the subject thoroughly and laid the foundation for treatment which is but now being

extended.

These extensions have proved of great value as supplemening but in no way supplanting the long established method of treatment; and here an anomaly has been created, for the virtue of some of these additions to the clinician's therapy cannot be satisfactorily explained in the light of the most recent and generally accepted physiological and pathological findings.

The explanation of the marked benefits which, in suitable cases, follow the adoption of "starvation days" is still confined within the limits of speculative generalisation.

The "oatmeal cure" as introduced by von Noorden runs counter to the general principles underlying the treatment of this disease, for in this method of treatment large amounts of carbohydrates are administered to an organism ill adapted to utilise this form of food.

Then with regard to "organotherapy." This, it was hoped, would make good the pancreatic deficiency which in many of the cases of severe diabetes is the cause of the glycosuria. Since von Mering and Minkowski in 1889 proved that complete removal of the pancreas in the dog was immediately followed by glycosuria, it has been generally accepted that pancreatic deficiency is closely connected with persistent excretion of sugar; and the analogy with myxoedema, in the treatment of which administration of thyroid gland is so successful, suggested the possibility of marked benefits following the

exhibition of an extract of the pancreas. In the hands of most workers however the results have not been encouraging.

In view of the variations in severity and symptoms which cases of diabetes present, of the different modes of treatment and of the varying success which follows their adoption, and at the same time recognising the innumerable and widely different conditions with which glycosuria is associated, it seems unlikely that organic disease of the pancreas is responsible for more than a small proportion of all cases. Its frequent association with exophthalmic goitre; after administration of thyroid extract; with disease of the pituitary body and with acromegaly; with organic lesions of the liver and pancreas; also its tendency to develop after prolonged mental anxiety and severe shock; after head injuries; during and after pregnancy; and its numerous manifestations in middle aged persons of gouty diathesis, together supply factors which extend its etiology far beyond the realm of pancreatic inadequacy and compel us to assume that the internal secretions either themselves or through their nervous control, or the nervous system itself, are, in some as yet undetermined way, failing to preserve that balance between metabolic and catabolic processes upon which carbohydrate stability depends.

Classification therefore upon an etiological basis seems at present impossible and so long as the symptom of glycosuria is persistently present, be it in small or large amount,

diabetes mellitus is the diagnosis made.

From the symptomatic standpoint however it is possible to divide the severe from the mild and chronic cases, and it is convenient for clinical purposes to do this, seeing that the conditions vary so widely.

In the opinion of the writer the title Diabetes Mellitus should be reserved for the severe cases characterised by polyuria, great thirst, hunger and rapid emaciation, which in their course are usually progressive and in which only the most grave prognosis can be given; while Glycosuria might be an appellation applicable to cases with either intermittent or constant small amount of sugar in the urine, the presence of which is often unsuspected and is frequently never suggested to the patient by any feeling of indisposition, which with careful treatment shews little disposition to markedly curtail the ordinary bodily activities and which is quite compatible with the expectation of average longevity.

If the prognosis of this disease is alone considered it is not only convenient but desirable that recognition of the differences in severity should be made and widely taught. In the minds of most patients diabetes mellitus has come to spell an incurable disease, and the term conveys an alarming impression of their condition.

Glycosuria would soon become associated with much more hopeful prospects.

TREATMENT

Carbohydrate Restriction or Exclusion.

Though somewhat modified by the empirical laws which food chemistry has established in recent years, this method of treatment stands in the foreground of diabetic therapy to-day just as it did after Rollo's time.

The aim of the modern dietetic treatment of diabetis mellitus is to preserve and if possible improve the general nutrition of the body, at the same time reducing or perhaps banishing the sugar from the urine. Considerations relative to the general health come first, those pertaining to the glycosuria second. Fortunately in the majority of cases, success in one direction is accompanied by improvement in the other.

The main objects to be gained by carbohydrate restriction are: -

1. Reduction of metabolic strain. The diabetic organism is unable to metabolise carbohydrates, it cannot utilise them to fulfil the requirements of the body tissues and the restricted diet provides these hyper-excited or inefficient processes with a period of rest, during which their tone becomes restored and their tolerance materially increased. To provide the requisite number of calories fats are increased in the diet and the patient obtains a physiologically satisfying

food which can be assimulated.

2. Reduction of Hyperglycaemia. Normal blood contains a trace of glucose, in diabetes the percentage is much increased and as a rule varies in proportion with the degree of glycosuria. It is stated that the relative proportion of the glycaemia to the glycosuria tends to become raised as the case becomes chronic, the explanation suggested being that the kidney becomes less permeable to sugar.

The tissues of the body therefore are continually bathed in blood in an abnormal condition, and this may explain the occurrence of the numerous complications to which the diabetic patient is prone. They are usually associated with the chronic cases and among the most frequent are pruritus, xanthoma, carbuncles, perforating ulcers, gangrene, optic neuritis and retinitis, cataract, peripheral neuritis, melancholia and dementia. Reduction of glycaemia diminishes the liability to these complications and greatly aids in their cure should any of them have developed.

The acute case is usually free from these added lesions; for he rapidly progresses and the fatal termination is reached before they have had time to develop.

3. To preserve and increase carbohydrate tolerance. One of the most important reasons for carbohydrate restriction is that in so doing the stimulus to further derangement of function is withdrawn.

The benefits to be derived are both immediate and progressive. Carbohydrates excite the sugar forming mechanism and their effect outlives the period during which they are administered. Reduction is not immediately followed by a corresponding diminution in the glycosuria; for the stimulus produces a reaction which subsides gradually, as the formerly overtaxed metabolic processes slowly regain their tolerance.

In diabetes the main danger lies in the future. It is the insidiously progressive nature of the disease which makes expectant treatment imperative. Administering carbohydrates may, in some cases, have the immediate effect of producing a period of well-being, but the final result is a permanently diminished tolerance.

The following figures illustrate the persistence of the exciting effects of a too liberal diet: -

Day	Diet	Sugar in Urine
1-3	Restricted - 20 gr. Bread	0
4	" 50 "	0
5	" " "	0
6	" " "	5.2 gr.
7	" " "	12.7 "
8	" - 20 "	11.3 "
9	" " "	8.2 "
10	" " "	7.1 "
11	" " "	4.9 "
12	" " "	6.4 "
13	" " "	0
14	" " "	0
15	" " "	0

So long as the diet contained 20 grammes of bread the urine remained sugar free. When the quantity was increased to 50 grammes however the urine on the third day of the altered diet contained sugar to the extent of 5.2 grammes, on the fourth day 12.7 grammes. The original diet was then returned to but it was not until five days had elapsed that freedom from sugar was again attained.

Before any method or any combination of methods of treatment in a case of diabetes mellitus can be determined upon, data relative to the metabolic capabilities of the patient as well as to the presented symptoms must be obtained. These differ widely in different cases. No routine line of treatment, however sound it may be in principle, can be applied to all cases. Each must be separately investigated and a diet adapted to and determined by these investigations must be adopted, and must be adjusted from time to time to meet the altering requirements of the case.

In working out a diet the first point to determine is the gravity of the case. In order to do this the intensity of the glycosuria must be estimated and the presence of any disturbance of nitrogenous equilibrium ascertained. To arrive at these conclusions the daily intake and output must be analysed. The latter is supplied from the urine whose sugar and nitrogen are worked out. The former is assessed from a diet of known composition which is given for a period

of three days. The urine of the third day is collected, carefully measured, and the above-mentioned analysis made.

The following is a suitable and convenient test diet:

Ounces		Protein grammes	Fat grammes	Carbohy: grammes	Calories
9	meat (beef or mutton)	56.1	72.0		900
	eggs 4	26.8	21.0		304
3½	green vegetables	.7	.1	.4	6
3	butter	.9	65.6		645
4	bread	11.2	1.6	63.6	360
		95.7	160.3	64.0	2215

Tea and coffee with little milk and no sugar may be given. Pavy has shewn that the proteins of the food yield a proportion of sugar which varies from 45 to 60 per cent.

Calculating from the smaller figure the total carbohydrate content of the above diet is -

Carbohydrate	64.0
Carbohydrate derivable from proteins	
45% of 95.7	43.0
	107.0 gs.

The nitrogen content of the urine can be taken as an index of protein metabolism, and the sugar obtainable from this source is calculated in the following way.

6.25 grammes of protein are equivalent to 1 gramme of nitrogen and each gramme of nitrogen can be accompanied in the protein molecule by an amount of sugar varying, according to different observers, from 2.8 to 4 grammes. If therefore the amount of urine nitrogen be multiplied by an average of these two estimates (say 3.5) the result will be the quantity of sugar obtainable from protein metabolism. Add to this the total carbohydrate intake, and the resulting figure represents the amount of sugar the urine might contain were the power of dealing with carbohydrates entirely lost.

The proportion between the amount of urinary sugar on the one hand, and the total made up of intake carbohydrate added to protein sugar estimated from the urinary nitrogen on the other, provides data upon which the gravity of the case is determined; and it affords a valuable index to the method of treatment to be adopted. Cammidge terms this ratio the Co-efficient of Excretion. If it is less than 1 the indications are that the power of assimilating carbohydrates though deficient is present to a certain degree; whereas if it be greater than 1 this power would appear to be lost, and more, that the excess of sugar is being excreted at the expense of the body tissues.

If under the above test diet a low Co-efficient of Excretion is obtained the patient is immediately placed upon a carbohydrate free diet, and daily estimations are made to

observe any alteration in the degree of glycosuria. Should this be successful in obtaining a sugar free urine small amounts of bread are added every second day until sugar again appears. The quantity of carbohydrate short of producing glycosuria is the limit of toleration, and the future diet should be worked out so that it contains an amount slightly less than this limit.

In cases in which toleration is so low that even small quantities of bread give rise to glycosuria, attempts have been made to substitute "diabetic breads" in order that a food stuff simulating bread in consistency, but stated to contain practically no starch, may form part of the diet. Many of these are now on the market, and enjoy extensive sale. Analysis has shewn that the majority of these proprietary breads contain almost as much starch as white bread, the percentage of carbohydrate being in some cases as high as 50.

The patient in whose diet such an article is included may therefore be unconsciously taking an amount of starch in excess of his limit of toleration. Those proprietary preparations that are reliable and which contain small quantities of starch are usually so unpalatable that patients soon tire of them. It is therefore safer practice to allow a small quantity of a bread whose composition is known, than to substitute a usually expensive proprietary preparation containing an unknown and often considerable amount of starch.

Should the Co-efficient of Excretion be high immediate and complete withdrawal of carbohydrates is not advisable for fear of inducing excessive and incomplete protein and fat metabolism, and leading finally to the most serious diabetic complication, acidosis.

In these severe cases the patient is treated more than the urine and his general condition is a matter for first consideration.

Gradual withdrawal of carbohydrates with constant watch for the appearance of acetonuria, or if it be already present for the symptoms which usher in diabetic coma, is a method fraught with less danger than sudden exclusion. Many of these cases can never be made sugar free and it is not always advisable that this should be aimed at. Attempts to do so by rigorously excluding carbohydrates diverts the activity of the sugar forming processes from the food to the body glycogen and in time this becomes depleted. The body glycogen contained chiefly in the muscles and the liver can be looked upon as a barrier of defence in preventing excessive protein metabolism.

In the hyperactivity of diabetes mellitus sugar is obtained first from the food carbohydrates; should these be completely excluded the stored glycogen is next utilised. Should this become depleted, proteins both of food and of body tissues, and probably the body fats, are the source from

which sugar is derived.

In the majority of severe cases the acetone bodies (oxybutyric acid, aceto-acetic acid, and acetone) are contained in the urine and it is this additional abnormality that makes the treatment of diabetes difficult. Glycosuria itself betrays faulty carbohydrate metabolism and its reduction can usually be achieved.

Acetonuria indicates defective power of dealing with proteins and fatty acids and is generally accepted as a contra-indication to complete exclusion of carbohydrates from the diet. Modern writers have shewn that the danger of inducing or increasing acetonuria by strict dietary is not so great as was once thought. By experience it has been shewn that in healthy persons acetone appears in the urine after a few days upon a carbohydrate free diet and disappears immediately upon resumption of the normal regime. Should however the unusual diet be persisted in the acetonuria tends to diminish.

It is found that in diabetes a similar sequence of events takes place; exclusion of carbohydrates at first tends to increase the acetonuria but if this can be safely continued reduction ultimately supervenes.

Should there be an increase of the acetonuria and with it excessive nitrogen excretion, and should signs of diabetic coma be exhibited, carbohydrates must at once be added to the diet

and alkalies administered in order to counteract the acidosis.

So long as there is a slight nitrogen addition to the body it is usually safe to diminish the carbohydrates in the diet, in spite of moderate acidosis.

Protein Restriction or Substitution.

While in the mild cases of diabetes strict measures to restrict or exclude carbohydrates from the diet are followed by success; in severe cases such a method of treatment is not always advisable and may be associated with considerable danger. In these latter cases other methods must be adopted and the restriction of proteins, or the substitution of one form of protein for another is frequently a valuable mode of combating the progress of the disease.

Diabetes mellitus is now recognised as a disease in which carbohydrate metabolism is not the only process which is at fault, and towards the rectifying of which remedial measures are alone directed. If this were the only factor to be considered treatment would be comparatively simple. In severe cases however proteins and probably fats become involved.

In his recent illuminating Harveian Oration Sir James Goodhart has, in recalling Pavy's work, referred to the important part played by proteins in the production of sugar. He says: "It has always seemed obvious, when one considers how greatly the output of sugar varies even under the most

rigid system of dieting, that the excreted sugar could not be a mere output of what has been taken in; that the human kiln has, in fact, the power of in some way coining sugar out of its own constituent elements; and I believe that Pavy's ultimate credit for a real step onward in this still intricate disease will rest upon his observation that the protein molecule is in some way split up, and that a carbohydrate molecule emerges therefrom."

Treatment in such cases is directed mainly against these added defects and the primary carbohydrate instability to which they are subsequent, no longer supplies the only consideration on which treatment is based.

To restore the nitrogen equilibrium and to bring about a reduction in the output of acetone bodies, proteins should be reduced until not more than 50-75 grammes are ingested in the day. The proteins of vegetable origin and of eggs are as a rule better tolerated than those derived from meats, as the following figures obtained from one of von Noorden's experiments illustrate:

Day	Diet	Sugar in Urine
1	250 gr. Oatmeal, 300 gr. Butter, 10 eggs (- 52 gr. proteins)	0.
2	" " "	0
3	" " "	0
4	" " "	0

Day	Diet.	Sugar in Urine.
5	250 gr. Oatmeal, 300 gr. Butter, 250 gr. steak (- 52 gr. proteins)	0
6	" " "	5.1
7	" " "	12.3
8	" " "	22.0
9	" " "	27.4
10	green vegetables, eggs, butter	5.0 daytime 0 night "
11	250 gr. Oatmeal, 300 gr. butter, 10 eggs	0
12	" " "	0
13	" " "	0

In this case the urine remained sugar free so long as egg protein was ingested; but on the day following the administering of a protein equivalent in the form of steak, sugar appeared and increased in amount on each of the four succeeding days. It disappeared immediately on a carbohydrate free diet and when the original ration was returned to the urine continued sugar free. Restriction of the proteins or substitution in type frequently exerts a beneficial effect upon the degree of acidosis and at the same time brings about a greater reduction of glycosuria than could be achieved by carbohydrate starvation alone.

Starvation Treatment.

Among the methods of treatment applied to diabetes mellitus the plan of interposing short periods of absolute

starvation among longer periods of a moderately restricted diet has not yet found a place; though the results to be obtained by it appear to warrant such recognition.

In some textbooks passing allusion to it is made, though the scant method of dealing with it does not, and probably is not intended to, convey to the reader much confidence that beneficial results will follow its use. Neither in lecture nor at the bedside is it taught.

The difficulty in inducing patients to undergo complete abstinence from food for anything more than a very short period probably explains to a certain extent why this mode of treatment is not more widely practiced. Firmly fixed in the public mind is the conviction that absence of food soon induces bodily weakness and loss of vigour, and tends to an undermining of the general health; that it is in fact a dangerous experiment.

It is probable too that it would have had wider vogue in this country had not supporters in other lands, notably America, lauded its powers to such an extent that it amounted, according to their reports, to little short of a panacea against human ills. The startling conclusions which enthusiasm prompted them to arrive at, as well as the widely varied conditions in which it was claimed suprising results ensued, and the, more often than not, absence of expression of clinical reasoning shewing why it was used and why and how results were

obtained, seemed to indicate a proprietary more than a purely professional and scientific interest in the treatment.

An attempt to explain this want of support from the medical profession of this country to a method of treatment widely utilised elsewhere, is of interest when the rationale of the plan is considered.

Among the elementary principles of treatment, rest to the injured part comes first, and when it is recalled that in all acute diseases and in all diseases associated with the alimentary tract natural appetite is either impaired or completely withdrawn,and the patient, at Nature's bidding, is left to provide for his immediate requirements of heat and energy from his own tissues; it is reasonable to conclude that in diabetes mellitus, which is essentially a disorder of digestion and assimilation, a logical treatment is supplied by temporary starvation in which complete rest is given to the digestive processes, and opportunity afforded for regaining partially or completely their power of dealing with carbohydrates.

In treatment by Carbohydrate Exclusion or by Protein Reduction definite beneficial results are obtained and the method now under consideration is a temporary extension of both these modes. By it the glycosuria is controlled, sometimes banished, but always reduced. This may be either by means of a reduction in the polyuria or in a diminution of

the percentage of sugar. Frequently both are obtained, sometimes to a surprising degree. With this reduction is usually associated considerable amelioration of the symptoms. Thirst is soon reduced to normal limits and the appetite so often excessive is brought within the bounds of the more normal tissue requirements which this treatment establishes. The reduction in polyuria secures less disturbed nights for the patient and far from experiencing increased weakness he usually expresses himself as feeling better in every way, and enjoys the relief, partial though it may be, from the distressing symptoms which in many cases have been so prolonged. The moral importance of this to the patient cannot be overestimated, and must be accepted as a most valuable result when it is considered that, particularly in this disease, the patient frequently develops a mental attitude which allows of little or no hope for the future.

With a reduction in the subjective symptoms a check is also made to the continued loss of weight.

It is true that when food is again taken after the fasting period sugar returns, but in a less percentage than before the fast. A second period again reduces or removes the sugar which again returns to a less degree when food is recommenced. A third fast again checks the output of sugar and after this the patient, if willing to live abstemiously, and conscientiously submits himself to a short fast every

month or so, will probably be able to keep his sugar at a low figure or even to banish it completely and permanently. It is natural that until experience can act as a guide this method of treatment should be looked upon as drastic and severe, and that dangerous developments should be apprehended from its use. In most cases however the treatment involves no suffering or hardship, no undesirable symptoms arise and one invariably finds that there is a subsequent improvement in the general condition.

As will be later referred to in dealing with Case 1 the danger of serious symptoms arising during starvation is definitely less than during periods of digestion. As will be shewn there tissue waste is greater while digestion is going on. The diseased processes appear to create then a relatively greater amount of effete material than when fasting.

Generalisations on the advantages to be derived from a treatment are of interest, and in a disease such as diabetes they usually centre themselves around the phenomena connected with internal secretions, metabolism and excretion. It would however be of inestimable value if from out the innumerable physiological experiments that have been made in the search for results upon which to base trustworthy interpretations of digestive phenomena, some made more clear these processes when altered, as they undoubtedly must be, during periods of starvation.

Examination made by Voit of the several tissues in animals which have been starved to death has brought out some interesting facts. Two cats of nearly equal weight were taken and fed equally for ten days; one was then killed and served as a standard for comparison. The other was starved for thirteen days and then its various organs were weighed and the relative loss of weight in each was calculated.

The loss of weight shewn in the pancreas is of particular interest here when consideration is being made of the treatment of a disease in which its functions are, in many cases, deficient.

Voit found that next to the heart, the brain and cord, and bone, the pancreas shewed relatively the smallest amount of loss. It might be said that of all organs closely associated with digestive functions the pancreas exhibited the least change after subjection to prolonged starvation. It is true its activity was greatly diminished during this period, but the same might, with equal accuracy, be said of all other organs connected with digestion.

In what way it withheld its component parts from the general wasting that was going on is not known. It might be that it has, at such time, the power of living at the expense of the other tissues. This view is more than confirmed by Howell who in his article on the internal secretion of the pancreas states that in fasting there is an increase in number

of the islands of Langerhans. Writing on this subject he says, "When the pancreas is subjected to prolonged and excessive activity, by the injection of secretin, for example, the number of islands is greatly increased, and the same result follows periods of prolonged inactivity, as in fasting." From Voit's experiment, together with Howell's researches, it would appear that the pancreas is not only capable, during starving periods, of preserving its tissues from dissolution, but more than this, it is able by drawing its nutrition from other parts of the body, to shew actual tissue increase; and, we might assume, to considerably augment its functioning power.

There is here then experimentally and physiologically more than justification for this treatment; there are indications which strongly support it.

Criticism may be raised against this deduction on the ground that these findings have been obtained from healthy tissues, and that attempt is being made to apply them to an organism already diseased. The results of the treatment supply the answer.

Except in the most severe and obstinate cases of diabetes the urine on the second day of fasting is sugar free, and it might be said that, the abnormality having been removed, the urine is for the time-being at least, in a healthy condition, as are also, it might be inferred, the processes which govern

sugar metabolism.

Following through treatment then and correlating the physiological result (the increase in number of the islands of Langerhans) with the clinical findings (the persistence of the diminution in the amount of sugar over prolonged periods),the legitimate inference is presented that starvation increases the functioning power of the pancreas as regards carbohydrate metabolism, that such increase is brought about by actual tissue development, that the hitherto inadequate processes are thereby augmented, and that the symptom indicative of this inadequacy, namely, the glycosuria, either disappears or is permanently reduced in degree.

In illustration of the results of this treatment details of 4 cases are given. Two of these represent the severe form of diabetes, while the other two are mild cases of glycosuria.

Case 1. H.L.

A man, aged 29, by trade a sea-going boilermaker, gave a history of polyuria going on for 2½ years prior to admission to hospital. Accompanying this was great thirst and hunger, increasing weakness, and loss of weight which the patient stated amounted to almost 7 stones. After these symptoms had existed for 18 months he was compelled to discontinue work on account of the feeling of general debility. His night's rest was disturbed by frequent micturition. He had occasional attacks of diarrhoea. The nature of the shock to which the patient was subjected and which shortly preceded the onset of the above symptoms is of interest. He was engaged in cleaning the interior of the boilers, the temperature of which was so high (220 F. to 240 F.) that wet porous cloths were tied over the mouth and nose to cool the inspired air. His cloth inadvertently fell off, he was overcome by the heat and was withdrawn in a state of unconsciousness and collapse.

Prior to this illness he had always been a healthy man. There was nothing in the family history pointing to a hereditary tendency to the disease. On examination patient was found to be somewhat emaciated, with skin harsh, dry and loose. The complexion was bright, the pupils dilated. The tongue was dry, raw and clean, typically "beefy" in appearance. Many of the teeth were loose. In the breath there was a marked odour of acetone.

On a moderately liberal test diet containing 1850 grains of carbohydrates he passed, on the third day, 155 ounces of urine containing 3645 grains of sugar. The urine also contained the acetone bodies. This case was therefore one of severe diabetes whose power of dealing with carbohydrates was not only entirely lost, but the excessive activities extracted or developed sugar from the body tissue to the extent (on this test diet) of 1795 grains.

While in hospital the patient was subjected to three periods of starvation, two of three and one of two days' duration, and the effect is illustrated in the following details: -

Day	Diet	Day's Urine Ounces	Sugar %	Grains
1-36	restricted	165 (average)	5.2	4085
37-54	"	157 "	4.5	3362
55	"	160	4.5	3456
56	"	180	4.3	3696
57	"	170	4	3264
58	starvation	168	3	2420
59	"	67	2.1	672
60	"	60	1.2	354
61	restricted	64	4	1228
62-65	"	91 (average)	3.6	1567
66	"	88	4	1685
67	starvation	86	3.4	1402
68	"	52	3.7	922
69	"	18	3	260
70	restricted	64	3.5	1065
71-78	"	85 (average)	4	1632
79	starvation	92	3.5	1545
80	"	34	1.2	195
81	restricted	28	2	268
82-96	"	78 (average)	3.4	1272

From the above figures it will be seen that on the second day of the first starvation period, marked reduction took place in the amount of urine passed, it decreased from 170 to 67 ounces, while the sugar percentage fell to 2.1%, to fall still further the next day to 1.2% with the 60 ounces of urine.

As was to be expected when food was resumed the sugar percentage increased, but a corresponding increase in the day's output of urine did not take place. Nor was this merely a transitory phase which gradually led back to a state of things similar to that which pertained before food was stopped. The daily discharge of urine remained below, on some days considerably below 100 ounces (average 88 ounces). This result cannot be assigned to any alteration made in the diet after the starvation period, from what was given before the cessation of food. The conditions before and after, so far as diet and general surroundings of the patient were concerned, were, so far as one could make them, exactly similar. Any result, or any change in the patient's condition could therefore be reasonably considered as a direct sequence to the abstinence from food.

During the next starvation period of three days the urine again decreased markedly and the sugar percentage fell, though not to so low a level as during the first fast. On return to food sugar increased while the urine again took up a lower

daily output.

Between the first and second fasts the daily output averaged 88 ounces, between the second and third the average was 81 ounces. At the third fast sugar, on the second day decreased to 1.2%, and on the return of food resumed its usual propertions. The urine did not shew any marked change; and during the remainder of the patient's stay in hospital (2 weeks) its daily average output was 78 ounces.

Taking therefore an average of the output prior to the fast days and comparing it with the average of the 2 weeks which followed the third period one finds that the quantity of urine was markedly decreased as also was the total output of sugar. A net average saving of 2225 grains of sugar per diem were effected. With reference to this case, therefore, which represented severe and progressive symptoms, two definite statements can be made.

1. The daily output of urine was reduced from an average of 162 ounces to an average of 78 ounces.

2. The daily output of sugar was reduced from an average of 3500 grains to an average of 1272 grains.

These two results were effected by three periods of absolute starvation, 2 of 3 days and 1 of 2 days' duration, which were interposed at intervals varying from 7 to 14 days in a period during which a restricted, but not carbohydrate free diet was given. This diet contained proteins, fats and

carbohydrates; it yielded approximately 2200 calories and contained the equivalent of 1650 grains of sugar.

From the standpoint of subjective symptoms three definite statements can be made.

1. Polyuria was markedly reduced.

2. Thirst was brought within normal limits.

3. Appetite was no longer excessive.

As might be expected from these results the general condition of the patient considerably improved and a feeling of well being was established.

As there had been, prior to treatment, long continued and progressive loss of weight, it is necessary to record the results in this direction. This patient stated that in the 2½ years before admission to hospital he had steadily lost weight to the extent of almost 7 stone. On admission he weighed 9 stone 1 lb; when discharged 3 months later he weighed 9 stone 3 lbs. It would seem then that here too a check had been placed to the onward progress of the disease. The danger of precipitating the onset of acidosis and diabetic coma in a case of this severity, by instituting a method of treatment at first sight so severe and drastic, is one which demands investigation. It is the fear of this which precludes, in severe cases, the total exclusion of carbohydrates; and it would seem, from analogous reasoning, that to go to the extreme of exclusion and withhold food completely was

courting the very danger which treatment should specially try to obviate and avert.

Acidosis as already mentioned is a condition brought about by excessive and incomplete metabolism of proteins, and fatty acids. It is an autointoxication.

An analysis of the intake and output on the day preceding the first fast, in the case under review, and of the output on the third day of the first starvation period, supply data by which comparisons can be made, and from which the degree of excessive metabolism and the corresponding degree of danger of acidosis can be gauged.

Day	Diet	Urine	Sugar %	Grains	Nitrogen
57	restricted	170 oz.	4	3264	11.3 grammes
	2200 calories			900 cals.	290 calories
	.....				
60	3rd day of	60 oz.	1.2	354	3.31 grammes
	starvation			92 cals.	84.8 calories.

From the nitrogen output the amount of protein metabolism and its calorific value is assessed.

Whether fasting or during digestion a certain amount of energy is required to maintain body heat and provide for muscular movement.

Approximately 1600 calories per diem are utilised in this way. Comparing "intake" with "output" this gives -

Day	Intake	Output	
57	2200 calories	Sugar	900 calories
		Nitrogen	290 "
		Body heat etc.	1600 "
			2790 calories
60	nil	Sugar	92 "
		Nitrogen	85 "
		Body heat etc.	1600 "
			1777 Calories.

During day 57 therefore 2200 calories were ingested with a total output of 2790 calories.

Provision for maintaining body temperature and for energy expended in the carrying out of the digestive functions and in any muscular movements, was made here by the ingested food. If the calorific value (1600) required for this provision be subtracted from the total food value (2200), then 600 calories of "intake" remain against 1190 calories of "output." There was therefore on this day an excess of expenditure amounting to 590 calories.

During day 60 there was no "intake" and total "output" amounted to 1777 calories. Most of this was made up of the 1600 calories required for body heat. This figure is common to both days. In the former day it is supplied from the food

ingested, on the latter day it is provided by the body tissues of the patient.

The metabolic processes connected with maintenance of body heat comprise, (1) radiation and conduction from the skin; (2) evaporation from the skin; (3) vaporisation of water from the lungs; processes which go on whether the organism is receiving nutrition or is being deprived of food. It is not necessary to assume that in this case of diabetes these processes were in an abnormal condition.

For the sake of argument it would be justifiable to place under the heading of "intake" on the starvation day 1600 calories, a heat value which has for its equivalent the amount of body tissues which, during that day were utilised in heat production; a heat value, moreover, the satisfying of which produced no undesirable toxic material.

As this figure (1600) can therefore appear in both the "intake" and "output" of the starvation day, its omission from both does not materially alter the conclusions which might be derived from the comparison of these two days.

As was shewn above, the excess of output over intake on the first day amounted to 590 calories.

On the starvation day (omitting the 1600 calories) loss to the body amounted to 177 calories.

There was therefore greater body waste (qua digestion) to the extent of 413 calories during digestive activity than

during its abeyance; and as this waste is an index of excessive metabolism, a condition which determines auto-intoxication from the circulating of endogenous poisons, it would appear that the patient was in definitely greater danger of developing diabetic coma while he was being fed than while he was fasting.

The foregoing deduction is of the utmost importance for it points to the conclusion that in severe cases of diabetes when acidosis is either threatened or is already present, complete abstinence from food, in spite of the provision for heat which has to be made by the body tissues, is the best means of warding off disaster, since tissue waste is actually less during fasting than during digestion.

The permanency of the beneficial effects following this mode of treatment is well illustrated by this case.

The writer is of opinion that by no other method could results have been obtained, having regard to the severity of the case, which would have persisted so long as they are doing in the case under consideration. It is now four months since the patient was discharged, during which time he has been attending as an outpatient. There has been no return of the polyuria, thirst is still normal, appetite is not excessive, and the man is now able to do light manual labour.

Case 2. J.C.

The patient, a young woman aged 24, was admitted to hospital complaining of great thirst and loss of weight. She stated that during the six weeks prior to admission she had lost 17 lbs. Two years before admission she underwent an operation for tuberculous perinephric abscess and nephrectomy was performed.

The excessive thirst had been present for eight weeks. On examination the patient was found to be an emaciated, sallow-complexioned girl. The pupils were somewhat dilated, the tongue red and raw looking. There was no pruritus but the skin over the arms and around the mouth was harsh, dry, and scaling. The urine contained sugar and acetone.

The patient after eleven days, during which a restricted carbohydrate diet was given, was subjected to a starvation period of 2 days. This was repeated after five days and again for the third time after a similar period had elapsed. The following details illustrate the effect on the sugar and urine outputs.

Day	Diet	Day's Urine Ounces	Sugar %	Grains
1-10	Restricted	95	5.8	2660
11	"	80	4.6	1766
12	Starvation	64	3.7	1137
13	"	32	nil	
14	Restricted	32	nil	
15	"	46	3.9	865
16	"	68	3.9	1272
17	"	62	1.7	504
18	"	60	1.5	432

Day	Diet	Day's Urine Ounces	Sugar %	Grains
19	Starvation	56	1.7	456
20	"	40	nil	
21	Restricted	30	nil	
22	"	48	.6	134
23	"	56	3.7	993
24	"	44	2.3	489
25	"	38	2.1	384
26	Starvation	60	1.5	432
27	"	52	a trace	
28	Restricted	24	nil	
29	"	52	1.1	273
30-47	"	42	1.2	240

It will be seen that from a previous average of 95 ounces containing 2660 grains of sugar, the second day's fast yielded 32 ounces of urine which were sugar free.

On returning to food sugar reappeared in diminished amount and the urine preserved a considerably lower daily output. The second and third fasts reduces the outputs still further and it will be noted that the percentage of sugar remained consistently lower than it previously had done.

As a period of 10 days preceded this treatment and a longer one of 18 days intervened between the last fast and the patient's discharge, opportunity was afforded of comparing the ultimate condition of the urine with what was present on admission.

As will be seen, the urine output was reduced from an average of 95 to 42 ounces and the sugar output from 2660 to 240, a net saving of 2420 grains per diem. Acetone was no longer in the urine.

This case, then, which represented a severe type of diabetes was considerably improved by the treatment; her subjective symptoms were relieved and she left hospital feeling considerably improved in health.

The patient bore the fasting periods well and exhibited no unwelcome symptoms.

The total suppression of sugar on the second day of each fast, and its reappearance as soon as food was again given, indicates that glycosuria is intimately connected with, if not directly caused by, immediate digestion. Immediate digestion is intended to imply actual intestinal digestive processes and the immediate absorption therefrom; in contradistinction to digestion which in its wider sense would comprise the transposition and transformation which the body glycogen undergoes in the course of its metabolism.

In the case under review, from an average of 2660 grains, which it may be assumed the patient had been passing regularly for at least several weeks, starvation in one day caused this quantity to disappear entirely.

Cessation of the digestive act therefore produced sugar free urine; as soon as the process of digestion recommenced sugar reappeared.

If glycogen instability is the cause of diabetes, why did not sugar continue to be excreted during digestive rest? One day's fast, it might reasonably be assumed, could not entirely

deplete the liver of its glycogen. During starvation, as regards carbohydrate metabolism, this patient exhibited no abnormality. The bodily functions were, during that time, being conducted with no lack of that balance by means of which carbohydrate digestion is regulated. This suggests that sugar production, in such a case, must be a local phenomenon associated with the immediate digestion of food in the alimentary tract and its absorption therefrom.

Case 3. B. M.

The patient, a man aged 48, by occupation a sailor, was admitted to hospital complaining of excessive thirst and appetite. This condition had developed three months after a severe accident when he was knocked down by a sea breaking on board, and sustained a compound fracture of both bones of the leg. Amputation was found necessary. When admitted for the medical complaint the symptoms had been present for four months. There was no loss of weight. The patient was a stout, healthy-looking man. The urine contained over 2% of sugar. There was no acetone.

The accompanying figures illustrate the progress of the case and the result of treatment: -

Day	Diet	Day's Urine Ounces	Sugar %	Grains
1-5	restricted	72	2.7%	931
6	starvation	64	nil	
7	"	60	nil	
8	restricted	68	.7%	225
9	"	64	nil	
10-14	"	48	1.7%	388
15	starvation	36	nil	
16	"	40	nil	
17-37	restricted	45	nil	except on one day when ½% was present

This was therefore a mild case of diabetes, one which could be designated "glycosuria." Starvation rapidly diminished the sugar which returned between the fasts to the extent of .7% and 1.7% on two days.

After the second period the sugar did not re-appear during the three weeks the patient remained in hospital, with one exception when ½% was present. Before discharge patient was receiving a moderately liberal carbohydrate diet.

It is hardly necessary to say that all subjective symptoms disappeared.

The patient has since discharge (5 months ago) kept in touch with the hospital from time to time, and when last examined the urine was found to be sugar free.

Case 4. S. R.

The patient, a woman aged 58, was admitted to hospital complaining of great thirst and frequency of micturition going on over a period of 2 years.

No cause could be ascribed nor did the family history reveal any hereditary tendency to the disease.

The patient was a stout woman, her cheeks were flushed, the tongue was furred.

On examination the urine was found to contain between 2 and 3% of sugar.

As the case presented mild symptoms it was decided to apply treatment by means of exclusion of carbohydrate. This was carried out for six days, but as sugar still remained starvation was adopted and the details give a striking illustration of the comparative results following these two methods of treatment.

Day	Diet	Day's Urine Ounces	Sugar %	Grains
1-5	restricted	53	2.7	686
6-11	carbohydrate free	44	1.1	230
12	starvation	44	1.1	230
13	"	58	nil	
14	restricted	44	"	
15	"	22	"	
16	"	32	"	
17	"	38	"	
18-28	"	41	"	

From the above data it will be seen that though the diet was for six days carbohydrate free sugar was still excreted in the urine. On the second day of starvation however it

disappeared, and up to the time the patient was discharged, two weeks later, the urine continued sugar free.

It is hardly necessary to point out that for the successful carrying out of this treatment the full and willing co-operation of the patient is essential. There is certainly a difficulty sometimes in securing this. In the mind of the seriously ill diabetic the suggestion of abstinence from food is to say the least alarming; his excessive hunger is at all times a great discomfort which in many cases prompts the patient to use any kind of craft and cunning to break through the dietetic rules laid down for him. If, however, his confidence in the beneficial results to be obtained can be established, and he can be persuaded to make the attempt, he is usually rewarded at the end of the first 24 hours by experiencing a decrease in the acuteness of his hunger, and relief from his thirst and polyuria.

The second and third day's fast are as a rule borne with greater ease than the first, the relief from symptoms continues, and persists to an appreciable and often surprising degree after food is returned to.

As diabetes mellitus is essentially a disease closely associated with the processes of digestion, steps must be taken to prevent accumulation of effete matter and of the reduction products of the excessive metabolism. In order to effect this regular and free movement of the bowels must be secured. At night a pill containing 1 grain of calomel and 3 grains of extract of Colocynth is given, followed in the morning by a

saline sufficient to produce free evacuation. This is continued through the fast periods in order that the danger of auto-intoxication may be reduced to a minimum.

Guelpa of Paris who, more than any other writer, has brought this method of treatment into prominence on the Continent, emphasises the necessity of free purgation during starvation.

He applies this mode of treatment to diabetes as well as to a wide range of disorders which have as their chief etiological factor some metabolic or digestive derangement, and his published cases reveal some remarkable results.

Throughout the whole period during which the fast days are being interposed, the patient should be kept in bed.

This is particularly necessary while food is being withheld, for during such times tissue waste should be reduced to a minimum; and more reliable data for purposes of comparison can be obtained, than could be were the patient up and about and expending a varying amount of daily energy.

In the foregoing an attempt has been made to bring forward certain facts in connection with a method of treatment of diabetes mellitus which has not received that attention which its value merits.

Treatment by total abstinence from food has been dealt with by the writer as an extension and combination of the older Carbohydrate Exclusion and the more recent Protein

Reduction methods. In both of these the abstinence is partial.

It has been sought to explain why this mode, though strongly advocated elsewhere, has so little vogue in this country. The rationale of the treatment has been indicated and physiological facts have been adduced which lend to it not only justification but strong support. The manner of carrying out the treatment has been described, and the question of the possibility of dangerous developments arising from its use has been answered.

Cases have been presented which illustrate clearly the benefits, not merely temporary, which are to be derived.

These results, together with the considerations presented by the above resumé of matters dealt with, enable the writer to come to the conclusion that this treatment, if carried out under careful supervision, is followed by results which cannot confidently be expected from other methods; that by its use severe cases, even though their sugar may not be completely removed, are relieved of their distressing symptoms and are greatly improved in their general health; while milder cases if persuaded to exercise care in their dietary and to undergo short fasting periods from time to time, either reduce their glycosuria to a low figure or banish it completely and permanently.

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The opportunity is taken here of expressing the writer's indebtedness to the teaching of Dr. Guthrie Rankin at the London School of Clinical Medicine, Dreadnought Hospital, Greenwich.

In the foregoing the alteration in the nomenclature of Diabetes Mellitus suggested by Dr. Guthrie Rankin has been followed.